

Ames, Iowa.
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HIGHWAY ENGINEERING

Iowa Semi-Centennial

The highway engineers of to-day are offered a rare opportunity,-- an opportunity for working out their ideals of public service and for performing most necessary functions in carrying into effect a program of State, Federal and county highway improvement which has become the greatest public activity, and which is destined to increase in importance for a period so long in the future it cannot now be defined. It is already certain that through economic handicaps such as the lack of necessary highway transportation, the necessary materials for highway building, the shortage of labor and such fundamental requirements of a great highway program, that programs of improvement which it was thought possible to push through in a period of perhaps five years will be continued over a much longer period. It is perhaps a very conservative estimate to say that the next decade and a half will be devoted largely to the building of the necessary primary highways of the nation.

As a nation we have been backward in highway improvement. The effect of accumulated indifference to highway conditions is now so evident that in characteristic American fashion we are attempting to overcome the handicap thus imposed, by unusual and feverish haste. There is no comparison between the status of highway building to-day and the situation which existed at the time the development of the railroads became the absorbing public activity. The railroads were built before the traffic developed, in fact, it is still an important function of the railroads to continue to develop traffic on their lines. The highway traffic is here. This year an excess of six million motor vehicles will demand service over the highways, and this demand is general.

So rapidly have the economic aspects of all conditions affecting the American family changed within the past three years that it is difficult to forecast the permanent effects that will result from the development of the motor vehicle in conjunction with improved roads. The State highway department of one of our larger States has estimated that the completion of approximately a 3,000-mile system of primary roads within the State will result in the saving of not less than \$25,000,000 annually to the owners of motor vehicles within the State. Yet this, perhaps, is an incidental benefit, for who is able to calculate in dollars the actual value to a commonwealth of a highway system which makes possible adequate local transportation facilities essential to the building of a far more efficient public school system, and to the stabilizing of agriculture by making possible to the country population all of those privileges that may be enjoyed by the town or city dweller. The rapid development of public support for highway improvement began in 1916 when the first Federal Aid Road Act was passed carrying a total appropriation of \$75,000,000 to be expended over the five-year period 1916-1921. The total expenditure for highway improvement in 1916 was approximately \$272,634,000. The two years following did not show a very considerable increase for during the war period it became impossible to carry on any more than the most necessary highway improvement. In fact, for the year 1918 only about one-half million dollars was paid out of Federal

Aid funds, but for the year 1920 it is estimated that there is available for expenditure approximately seven hundred eighty-three millions of dollars. The growth in appropriations by years is shown in the following table:

Year	Total
1916	\$272,634,413.00
1917	279,915,332.00
1918	286,098,192.00
1919 (estimated)	303,670,105.00
1920 (estimated available for expenditure)	783,000,000.00

It is certain that it will not be possible to expend nearly the amount available for this year. It is doubtful if the expenditure will reach fifty per cent of the available funds. And so, for the first time, the handicap of lack of financial support is removed from the highway engineer, and although the highway improvement program is laboring under embarrassing and increasingly difficult problems, these difficulties are now of material things.

With the public enthusiastically backing the highway program, the engineer finds his duties confined to engineering and administrative problems, and not, as has been true in the past, to propaganda and educational work with seemingly meager results. The extent of the Federal and State aid program agreed upon is so enormous that it bears little relation to our previous efforts. Up to April 30, 1920, projects had been approved, that is, projects had been accepted for Federal Aid, totaling 27,796 miles including all types of highways. This mileage is estimated to cost a total of \$355,754,799.00, of which approximately \$152,000,000 is Federal Aid and \$203,000,000 State and other funds. There have been completed approximately 4,301 miles, and there are approximately 9,200 miles under contract. The types of highways involved include all kinds from earth up to and including all standard forms of paving of the most modern types, but by far the larger percentage of the funds will be spent for highways having durable surfaces, and in all cases the construction is considered substantial and adequate for the traffic which it will be called upon to bear. It will be noted that there are many sections of the country in which the road work is in a pioneer state. There are many States in which highway development is taking place for the first time in any adequate way, and in these it will be necessary, in order to give service to the area required, to use a cheaper type of highway construction than is now necessary in the vicinity of our larger population centers. An analysis of the types of construction which have been approved up to March 31 of this year, involving a total expenditure of more than \$326,000,000, shows that all the types which are contemplated may be separated into three groups. Group one includes the earth, sand-clay and gravel. These are the types of construction used where the highway traffic is light but where a large mileage is necessary to give service, but they include the fundamental construction necessary, regardless of the later surfaces which may be placed. In this group will be invested 26 per cent of the total estimated cost. In the second group are included water-bound macadam, bituminous macadam, and miscellaneous intermediate types. For this group 9 per cent of the total estimated cost will be expended. In group three are included bituminous concrete, Portland

cement concrete, brick, and other miscellaneous high types. For this group will be expended approximately 60 per cent. For bridges, practically all of permanent construction, a total of 5 per cent of the above estimated cost will be expended. The schedule follows:

Earth	8%)		
Sand-clay	3%)	Low types	26%
Gravel	15%)		

Waterbound macadam	2%)		
" " mat-top	1%)		
		Intermediate types	9%
Bituminous Macadam	5%)		
Miscellaneous intermediate types	1%)		

Bituminous Concrete	6%)		
Concrete	41%)	High types	60%
Brick	6%)		
Miscellaneous high types	7%)		

Miscellaneous types	5%)		5%

It is apparent from this analysis that the expenditure of Federal and State aid funds is being very carefully considered from the standpoint of an investment on the part of the public, and that highway engineering has developed to the point where the investment of large sums may be undertaken with reasonable assurance on the part of the public that the expenditures will be made, in the main, for the roads which will give the most economical service, if there is proper regulation of the maximum loads.

In addition to the large Federal and State programs the counties and even smaller districts have provided funds for the building of county and roads of lesser importance, and wherever construction of the better classes is undertaken, engineers, as rapidly as they can be secured, are being placed in charge of the construction work. Perhaps one other schedule is enlightening to indicate the rapidity with which engineers are coming into their own in the field of highway improvements. In 1916 it is estimated that approximately \$74,000,000 was spent under control of the State highway departments, but under local control was spent \$198,000,000. In 1920 the estimated sums available for expenditure under the Federal and State departments were \$633,000,000 and under local control \$150,000,000. Thus in four years the percentage of total available funds placed under engineering control has advanced from 27 to 81 per cent. As stated before, the actual economic limitations on expenditures this year will doubtless reduce the amount expended, but the schedule is enlightening as indicating the tendency to bring all highway expenditures under efficient engineering jurisdiction.

Year	Under Control State Highway Dept.	Locally but not under S. H. D.	Per cent under Hwy. Dept. Control
1916	\$74,495,554.29	\$198,138,559	27
1917	98,179,332.11	181,736,000	35
1918	117,285,267.82	168,812,923	41
1919	133,670,105 *	160,000,000	46
1920	633,000,000 * *	150,000,000	81

* Estimated

* * Estimated available

This, in a very broad way, outlines something of the status of the highway improvement program as it exists today, and is clearly indicative of the fact that the nation as a whole has set forth upon a permanent policy of highway development already too long delayed, that will in the years just ahead bring results far greater than were dreamed possible by the most ardent highway enthusiasts even so short a time since as 1916.

It is a cause for congratulations when this great college has called back all of its alumni and its friends to celebrate fifty years of service to the State of Iowa, to know that the State has definitely placed herself in the foremost rank with the States that have undertaken an extensive and adequate program of highway improvement. In reflecting upon all of the achievements of the college in this fifty years of its developing usefulness to the State, it seems to me there has been no service more definitely performed or one in which the results are more tangibly evident than the relation which the college has borne and the influence which it has exerted in helping to build for the State an adequate system of highway laws and of highway administration. The future outlook for highway development in the State is bright indeed, and it is brighter because the developments which have taken place for the past fifteen years or more have been founded upon high ideals of public service and have been backed by the integrity of a great educational institution which in its period of existence has come very close to practically every individual within the State. Without the influence of such an institution and without the support which it has given, the present outlook for a clean, efficiently administered highway program might well have been supplanted by a development of quite a different character. In 1904 the college as an institution was constituted the highway commission for the State. The work was placed under the joint direction of the engineering and the agricultural departments, with the Deans of these departments acting in the capacity of commissioners. The first appropriation was \$3500 a year. There were frequently times when there were not sufficient stamps to send out the mail, and even more frequently, times when salaries were paid once in three months. At that time the only highway departments that had been established were in the Eastern States where all conditions were materially different than those existing in a pre-eminent agricultural State. There was not the concentration of wealth, of population, of traffic, nor the availability of suitable road building materials to make possible at that time the character of highway work that was being developed by the established departments. Even the departments which had been established were only feeling their way.

Prior to the establishment of the college as a highway commission in 1904, a considerable amount of investigation had been carried on through students in the civil engineering department, because of the interest and foresight of the Dean of Engineering, who sensed the importance of improved highways to the State, even under conditions as they then existed. It is probably a fortunate thing that very limited funds were available for the early work because it made possible only the carrying on of systematic studies of the expenditures which were being made by local road authorities and the developing of those forms of cheaper types of improvement which appeared suited to the needs of the State. Also, it brought the limited force of the commission necessarily into close contact with the local road officials. It was only through securing the confidence and cooperation of these men in different sections that it was possible to secure the application of any of the principles which were developed as the fundamentals upon which could be built a sound administrative policy for the State. It became evident very early in the studies of the commission that because of the topography, climatic conditions, and the character of the soil, that the bridge and culvert problem was the most important problem from the financial standpoint, and that this item was absorbing practically all of the road revenues then raised.

So the early work of the Commission was centered upon the development of more permanent types of construction, and after experimental work with small concrete culverts and bridges, standards were provided and circulated among the county officials, and wherever possible the road officials were persuaded to try out the more permanent forms of construction, and even assisted in installing demonstration culverts upon which they could pattern future work. It seemed a long period before any tangible results were secured from this campaign, but finally the work of the Commission became sufficient to attract the attention of powerful bridge interests which sought to eliminate the influence of the Commission from what these selfish interests termed "undue interference with their business interests." A little later patented forms of construction attempted to fasten themselves upon the necessities of the State for better bridges, and so began a fight that lasted over many years until the courts finally destroyed all future hopes of such interests by sweeping decisions as to the validity of their so-called patents. There was one particular time in this period when the whole integrity and strength of the college were placed squarely behind the Commission. An investigation of the Commission was demanded on the part of the Board of Education because of the charges which had been made by the Commission against the practices which were current among the bridge interests at the time. It was thought that sufficient political and business pressure could be brought upon the Board of Education to force it to withdraw support from the work of the Commission, with the almost certain attendant abolishment of the Commission as a State agency by legislative enactment. The Directors of the Commission placed the facts squarely before the President of the Board of Education, who listened attentively, and at the conclusion of the interview made the sole comment, "We will support you in this fight." There is perhaps no incident more typical of the support and assistance which the college gave the Commission during the early formative period than this one.

A little later, disclosures of excessive charges and corrupt practices in more than one county of the State brought forcibly to the attention of the public the real condition of affairs, and in 1913, sweeping changes were made in the highway laws and the form of commission changed from the college as an institution to a Board of three members, of which the Dean of Engineering is ex-officio one of the members. At the same time adequate appropriations were made for carrying on the work of the Commission, standards for all forms of construction, both road and bridge, were adopted and put into use, and the Commission given supervisory control over all the expenditures within the State. There is at present no State which has placed as complete supervisory jurisdiction over all expenditures for road purposes, as has the State of Iowa. The period of re-organization under the new law was a strenuous one, but the principles of cooperation with the local officials which had been building during the previous period, after a comparatively short time convinced even the more skeptical officials of the sincerity and ideals of public service actuating the Commission in its efforts to improve the standards of highway improvement and highway expenditure in the State. In this legislation was established the principle of road classification, and through cooperation of the county officials and the Commission, a system of the most important county highways was selected out and designated for first improvements. But the legislation was not yet complete. The growth of motor traffic, particularly the growth in the use of the freight-carrying heavy motor vehicle, made it apparent that funds must be provided for the improvement of certain of the most heavily traveled roads with the most modern type of durable paved surfaces, and that it would be necessary to make another more limited selection of highways which would be designated for improvement as the primary road system. This legislation was made part of the laws in 1918, and aside from minor modifications which will become necessary from time to time as conditions change, or as defects appear, the State now has a complete system of highway legislation which provides for the improvement of highways in the order of their importance and in accordance with the wishes of the people in the various communities. The spirit of cooperation between the State and local officials has been enacted into the legislation throughout, and every encouragement has been given to local initiative. The plans now for financing the cost of highway improvement are apparently adequate and the rate of the improvement of all classes of roads will be dependent solely upon the economic resources which may be developed for this purpose. In the training of men for the organization, in the carrying on of research work, in housing the Commission, in extending to the road officials of the State every year its hospitality, in the interest of its alumni and its friends, and in the constant devotion and sacrifice made by its officials, the Iowa State College has been the potent influence in bringing the highway Commission and the county engineers into a strong and stable status in the State, and in placing the work of highway improvement on a clear and highly professional basis. It has rendered a great service to the State, a service which will not be entirely recorded in the more efficient expenditure of road funds or in the higher class of road improvements which are developing so rapidly. A major part of the record will be the demonstration of the service that an educational institution closely in contact with the needs and wishes of the public which it serves can render in the interests of higher ideals of public service and of good government.

But its work is not yet done. There is an immense amount of research work which must be carried on to point the way which highway improvement must take if it would adequately serve present and future traffic demands. There is a large number of young men who must be trained every year for the highway program. A recent estimate shows that all of the civil engineers of all the institutions would be absorbed each year in highway engineering alone, so the work which has been so well begun and has been carried so far is not yet brought to a close and will not be so long as the institution shall exist.